

REPORT

SITE INVESTIGATION
OIL STORAGE TANK AREA

ARMCO KANSAS CITY WORKS
KANSAS CITY, MISSOURI

PREPARED FOR

ARMCO INC.
KANSAS CITY, MISSOURI

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PROJECT NO. 89118

REMCOR, INC.
PITTSBURGH, PENNSYLVANIA



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RCRA RECORDS CENTER

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1.0 INTRODUCTION

Under contract to Armco Inc. (Armco), Remcor, Inc. (Remcor) has conducted an evaluation of the area associated with the formerly used oil storage tank south of U.S. Highway 24 at the Armco Kansas City Works in Kansas City, Missouri (Figure 1). The investigation was conducted to evaluate the current conditions of this area with respect to the reported presence of petroleum hydrocarbon (PHC) contamination along the right bank of the (Big) Blue River.

This study has involved drilling and subsurface sampling, as well as the compilation of previously collected site data. Such data include information from the U.S. Army Corps of Engineers (COE), Kansas City District, regarding the rechannelization of the adjacent Blue River. Corrective measures to abate potential oil and grease (O/G) discharges to the river were also evaluated.

This investigation was conducted by Remcor during the period of May 1 through 5, 1989. This report presents the findings of the investigation conducted at the site, as well as a description of the proposed corrective measure.

1.1 BACKGROUND

As the rechannelization work for the Blue River has proceeded, the COE identified apparent PHC contamination in certain bank soils. The right bank between river Stations 518+00 and 522+50 was identified by COE subcontractors as potentially contaminated by oil. This area (approximately 2.5 acres) is adjacent to a formerly used oil storage tank owned by Armco (Figure 2).

1.1.1 Tank Description

The oil storage tank at the Armco facility measures approximately 60 feet in diameter by 40 feet high with a nominal capacity of 20,000 barrels (840,000 gallons). The tank was installed in 1951 and removed from service in 1982. Most recently the tank was used to store No. 2 fuel

oil, but had contained No. 6 fuel oil before 1962. Currently the tank is empty, and the associated product transfer stations have been abandoned.

The oil unloading platform area was formerly used to transfer product from rail cars for distribution. Adjacent to the oil unloading platform was a surface drain with a 12-inch pipe discharging to the bank of the Blue River. A 10-inch diameter pipe associated with the containment dike around the tank also discharged to the bank of the Blue River.

1.1.2 Results of Past Sampling

During November and December 1988, the COE collected soil samples in the river bank area near the Armco tank. These samples were analyzed for the following:

- pH
- Volatile organic compounds (VOCs) (including benzene, toluene, and xylene [BTX])
- Base/neutral and acid extractable (BNA) compounds
- Polychlorinated biphenyls (PCBs)
- PHC
- O/G.

Analytical results showed PHC concentrations ranging from 161 to 827 milligrams per kilogram (mg/kg) and O/G concentrations ranging from 240 to 991 mg/kg. No PCBs were detected, and VOCs (attributable to PHC presence) were detected only in the one sample with the highest PHC and O/G concentrations. These analytical data are summarized in Table 1.

Analysis of BNA compounds was also performed on the sample with the highest O/G concentration. This analysis indicated the presence of base neutral semi-volatile compounds related to the presence of free hydrocarbons. These compounds are listed in the laboratory data sheets included as Appendix A. None of the acid extractable semi-volatile compounds (i.e., phenols) was detected in this analysis.

Additional soil samples were subsequently collected by the COE from nine borings installed during the period of December 29, 1988 through January 10, 1989. These samples were analyzed for PHC and O/G only. Analytical results indicated PHC concentrations ranging to 8,700 mg/kg and O/G concentrations ranging to 9,500 mg/kg. A "fingerprinting" process was used to determine that the source of the PHC and O/G contamination was primarily No. 6 fuel oil in both weathered and unweathered states; some No. 2 fuel oil was present as well. These sample results are also included in Table 1.

The Missouri Department of Natural Resources (MDNR) was notified of the COE findings and suggested that Armco investigate the possibility of this contamination originating at the Armco-owned storage tank. The following sections describe the investigation that Remcor implemented on Armco's behalf.

2.0 PROJECT OBJECTIVES

The Remcor investigation focused on the determination of the source of PHC found in the COE work area and potential relationship to the above-ground oil tank. Borings were located to give evidence to the origins of the PHC, as well as to give indications of subsurface conditions at the site. All but one of the borings were located proximal to the oil unloading platform and the permanent river channel right-of-way (Figure 2).

2.1 INVESTIGATION METHODS

2.1.1 Test Borings and Soil Sampling

Twelve shallow test borings were advanced by a small geotechnical drill rig utilizing hollow-stem augers and split-spoon samplers. Split-spoon samples were collected in accordance with the American Society for Testing and Materials (ASTM) Method D 1586-74, and standard penetration resistance (SPR) was recorded. Each split-spoon sample was visually identified in accordance with the Unified Soil Classification System (USCS) by the on-site Remcor geologist. Boring logs were developed to include the SPR, as well as USCS classification; these boring logs are included in Appendix B.

To reduce the potential for cross contamination of samples, split-spoon samplers were thoroughly decontaminated prior to each use. Laboratory detergent and water were used to wash the split-spoon samplers, and they were then rinsed with clean water. Other downhole equipment, which could not be decontaminated by the above method, were steam cleaned prior to each use.

Soil samples were screened in the field for the presence of oil by submersing a small aliquot of sample in a jar of water and observing for the presence of an oil sheen. This simple screening method aided in the selection of samples for laboratory analysis.

During the COE investigations, both total PHC and O/G were analyzed in each sample. Due to the excellent correlation between PHC and O/G, Remcor elected to analyze O/G only for each sample. Figure 3 shows the relationship between O/G and PHC. During the Remcor investigation, a total of 32 samples were collected from borings located in the oil unloading platform area and analyzed for O/G. Nine of these soil samples were also analyzed for extraction procedure (EP) toxic chromium and lead.

Each of the soil samples (for analysis) was collected into a laboratory-prepared 250-milliliter (ml) glass sample jar with a Teflon®-lined lid. The sample label affixed to each jar contained the following information:

- Sample identification number
- Client name (Remcor) and project number
- Date and time of sample collection
- Boring number and sample depth
- Analytical suite
- Sampler's initials.

Each sample was assigned a unique sample number that could identify the Remcor project, as well as boring number and a sequential digit referring to the number of samples collected at the boring. Each sample was subsequently logged onto a chain-of-custody form. Chain-of-custody protocols were strictly followed in accordance with standard procedures employed by Remcor. Samples were then placed into a cooler for shipment to the analytical laboratory.

2.1.2 Shallow Test Pits

Four shallow test pits (i.e., TP-1 through TP-4) were located in the COE work area (Figure 2) to evaluate the presence of free hydrocarbons on top of the ground water table. These test pits were each excavated by hand to an approximate depth of 1.0 feet. No soil samples were collected from the test pits. An oil sample was collected from Test Pit TP-1 and analyzed for EP toxic chromium and lead.

3.0 SITE CHARACTERIZATION

This chapter presents the findings of the site investigation. The regional setting is first described based on reports by the U.S. Department of the Interior, Geological Survey (USGS) and the MDNR. The site-specific conditions in the oil tank area are then discussed.

3.1 REGIONAL SETTING

The following sections outline important aspects of the regional environmental setting.

3.1.1 Topography and Drainage

The Kansas City, Missouri region is an area of rolling and plain topography with dendritic streams of mature developmental stage (McCourt, et al., 1917). Stream valleys are wide and flat-bottomed; meandering streams and oxbow lakes are common.

At Kansas City, the average discharge of the Missouri River is 51,000 cubic feet per second (cfs) (Jordan, 1984). In comparison, the average discharge of the Blue River, near its confluence with the Missouri, is on the order of 200 cfs (Waite, 1987). The approximate 100-year flood elevation of the Missouri River at Kansas City is 738 feet mean sea level (ft-msl). Because the flow of the Missouri River is highly regulated in this area, a 100-year flood may be the function of regulation and not runoff. For this reason, the USGS is reluctant to recognize an official 100-year flood elevation (Waite, 1987). Flood elevations along the Blue River are not available due to ongoing rechannelization efforts.

3.1.2 Geology

The site region is part of the Osage Plains portion of the Interior Plains physiographic province (Emmett, 1985; Anderson, et al., 1979), located midway between the Ozark Plateau and the Great Plains (McCourt, et al., 1917). The geology of the Osage Plains is relatively uncomplicated, predominated by relatively flat-lying sedimentary rocks (dipping

10 to 20 feet per mile to the west-northwest) and unconsolidated alluvial deposits in the valleys (Parizek, et al., 1968).

Figure 4 is a generalized geologic cross section through the site area. As illustrated in this figure, five geologic units are present in this area (Parizek, et al., 1968):

- Marmaton Group
- Pleasanton Group
- Kansas City Group - Bronson Subgroup
- Kansas City Group - Linn Subgroup
- Blue River Alluvium.

These units are Pennsylvanian in age, except for the alluvium, which is of the Quaternary period.

The oldest bedrock unit of these listed, the Marmaton Group, consists of an upper shale, median limestone, and basal sandstone (Anderson, 1979). According to Parizek, et al. (1968), this unit is present at a depth of approximately 100 feet below the ground surface in the area of the Kansas City Works (Figure 4).

Overlying the Marmaton is the Pleasanton Group, comprised of argillaceous to sandy, micaceous shale. Thin, fossiliferous siltstone beds are also present in upper portions of the group (Parizek, et al., 1968). This unit is exposed in the vicinity of the Blue River near the Armco facility. The upper surface of this unit appears to be at the approximate elevation of Interstate 435 (I-435) to the southeast of the site, based on visual identification by Remcor.

The bedrock units lying above the Pleasanton Group consist of the Bronson and Linn Subgroups of the Kansas City Group. Both of these members of the Kansas City Group have been removed by erosion in the vicinity of the Armco facility. The Bronson Subgroup consists of a cyclic sequence of three major limestones separated by shale and clay units. The limestones are commonly quarried, but also deep-mined in areas of high-quality material. These mining methods have left mine adits, which have

been used by some industries for various purposes. The Linn Subgroup consists of shales, a few persistent limestones, and some thin sandstones.

Locally derived alluvium lines the valley bottom along the Blue River. Near the Armco facility, this material may be as much as 30 feet thick (Parizek, et al., 1968). Based on data provided by exploratory geotechnical drilling performed for the COE in preparation for the Blue River rechannelization project (COE, 1983), the natural alluvial deposits consist primarily of high- and low-plasticity clays (CH and CL). Sandy clays (SC) and poorly graded sands (SP) exist at depth, buried by the clayey and silty surface materials.

3.1.3 Hydrogeology

Aquifers of the site region may occur in either bedrock or unconsolidated materials. Bedrock aquifers typically consist of sandstones, where permeability is controlled by primary porosity, or within limestone, where permeability is generally a function of the density and interconnection of fractures. Typical yields from domestic wells tapping the bedrock aquifer(s) range to less than 20 gallons per minute (gpm) (Imes, 1987). Near major rivers, these bedrock aquifers are not commonly used for domestic, industrial, or municipal water supplies. Unconsolidated formations, such as glacial drift, are relatively unimportant as aquifers in the Kansas City area. These drift deposits are typically thin mantles of silty clay material that transmit very little water.

Deposits of alluvium along major rivers (e.g., Missouri River) are widely used for water supply by both industry and individuals. Wells developed in these deposits commonly yield on the order of several thousand gpm (Emmett, 1985). Ground water is typically encountered at shallow depths (less than 20 feet) with flow directions toward and in the downstream direction of the alluvial valleys.

3.2 SITE SUBSURFACE CONDITIONS

Subsurface data were available from the 11 borings located at and adjacent to the oil unloading platform area, as well as from one boring located approximately 300 feet west of the investigation area. The boring logs from these borings indicate the presence of the following stratigraphic sequence:

- Mill scale fill
- Steel mill slag fill
- Steel mill slag mixed with silt fill
- Silt and clay (Blue River Alluvium).

Figure 5 shows a site-specific cross section extending from the western boring to the Blue River. The topographic profile (shown at a 5x vertical exaggeration) was developed from both field observations and COE re-channelization design drawings with relative elevations (in feet) above an arbitrary datum. Several borings that provide key data have been projected to the cross section. The 12-inch drain pipe from the oil handling area is also shown in perspective on the section.

Ground water was encountered under phreatic conditions across the site and found to be discharging toward the Blue River. Some low-lying areas in the COE work area were found to show ground water seeps. These seeps were located near the lower contact of the fill materials. Ground water recharge to the water table is west of the site. In the immediate vicinity of the oil unloading platform, ground water discharges from the lower portion of the steel mill scale and scale with silt fill materials to the Blue River Alluvium.

Based on visual identification of the fill materials and the alluvium, the difference in hydraulic conductivities is believed to be as much as three orders of magnitude (Freeze and Cherry, 1979). The fill material is generally a sandy to coarse-grain scale, which, in its lower portions, is mixed with various amounts of silt. The alluvial material is dominated by silt with clay, showing some sand to sandy lenses and abundant plant remains (Appendix B).

Samples collected from each of the borings in the oil unloading platform area are listed in Table 2. In addition to analytical results, the table lists each sample, depth sampled, material sampled, and the stratigraphic relationships to the water table.

3.3 ANALYTICAL RESULTS

3.3.1 Oil Unloading Platform Area

Five borings (i.e., TB-1, TB-2, TB-4, TB-11, TB-12) were drilled on Armco property into the slag fill area around the oil unloading platform. Due to the extremely dense nature of the fill, only one boring (TB-1B) could be advanced completely through the fill. Whenever refusal was encountered before the objectives of the boring were met, another boring was drilled in the immediate area and identified with the same boring number and a letter suffix.

Soil samples collected at these borings indicate the overlying mill scale to contain concentrations of O/G less than 0.1 percent. The sample collected from 0.0 to 0.8 feet at TB-1 showed 7,700 micrograms per gram ($\mu\text{g/g}$) O/G. At a depth of 8.0 to 9.0 feet (in the unsaturated zone), the O/G concentration in a sand fill was 63 $\mu\text{g/g}$. The dense slag fill at the water table in the same boring showed 2,300 $\mu\text{g/g}$ O/G, nondetectable EP toxic chromium, and 0.1 milligram per liter (mg/l) EP toxic lead. Deeper samples (below the water table) showed 95 and 53 $\mu\text{g/g}$ O/G, respectively. Borings TB-4 and TB-11 were each attempted to be advanced to the water table; however, auger refusal was met in each before encountering water. Samples from these borings were each collected between 3.0 and 5.0 feet, and results showed O/G from 110 to 170 $\mu\text{g/g}$.

Borings TB-2 and TB-12 were advanced to depths of 11.0 and 9.0 feet, respectively. Based on the log of TB-2, ground water is believed to exist at a depth of approximately 9 feet (Figure 5). Samples from TB-2 collected at depths of 3.0 to 4.0 feet and 10.0 to 11.0 feet showed O/G concentrations of 200 and 100 $\mu\text{g/g}$, respectively; the EP toxicity result of 0.4 mg/l lead was found in the 10.0- to 11.0-foot sample. The sample

collected at TB-12 at a depth of 6.0 to 9.0 feet showed O/G concentrations of 2,500 µg/g. Because split-spoon samplers could not be driven at this location, this sample was collected from the augers; it is believed to be representative of the materials between 6.0 and 9.0 feet (immediately above the water table). Observations of water levels and determinations of whether floating product exists could not be made at Borings TB-2 or TB-12.

As illustrated in the cross section (Figure 5), the bottom of the fill occurs at a maximum thickness of 15.5 feet over a gray silt or silty clay alluvium. At the western limit of the facility, the fill is approximately 4 feet thick based on the log from the boring located in that area.

The pattern of subsurface O/G concentrations in the oil unloading platform area suggests historic surface spillage of petroleum products. These materials would then migrate downward and tend to accumulate (in the fill) at the ground water table.

3.3.2 River Bank Area

Borings TB-5 through TB-10 were installed along the right bank of the Blue River on the city of Kansas City property. The borings were placed in a line from south to north at relatively equal spacing (Figure 2). Each boring was advanced to a depth of 8.0 to 12.0 feet (at least 5 feet below the top of the water-bearing zone). A total of 21 soil samples was collected from these borings and analyzed for O/G, six of which were analyzed for EP toxic chromium and lead. EP toxicity analysis showed detectable lead at Borings TB-6, TB-7, and TB-9 ranging from 0.1 mg/l to 0.3 mg/l and no detectable chromium.

Results of analyses of seven samples collected at Borings TB-5 and TB-6, the southernmost borings, showed O/G levels from nondetectable to 480 µg/g. Water levels were observed at these two borings and indicated only very faint oil sheens. These water levels were found to rise approximately 1.5 feet after drilling.

Boring TB-7 appears to represent the southern limit of significant O/G contamination at the site. Although O/G levels in the soil were relatively low (ranging to 370 $\mu\text{g/g}$), a thin layer of light oil was observed on the water table. As with Borings TB-5 and TB-6, the water level in TB-7 was found to rise approximately 1.5 feet after drilling.

Boring TB-8 was logged to have a zone of oil-saturated soil approximately 1.5 feet thick. A soil sample collected from this zone showed 4,000 $\mu\text{g/g}$ O/G. To assess the quantity of floating product, a special piezometer was installed to measure the thickness of the free oil. The construction details of this piezometer are shown in Appendix C. Measurements made at this piezometer, approximately 24 hours after its installation, indicated approximately 1 inch of oil floating on the water table. It was uncertain, however, whether this measurement was made under static (equilibrium) conditions, and an additional measurement was made after one month. This second measurement indicated an approximate accumulation of 1.5 inches of product. Since the design of this piezometer is not susceptible to oil accumulation amplification associated with conventional piezometers, these oil thicknesses are believed to represent the thickness of product on the aquifer.

In Boring TB-9, ground water with free oil was encountered at approximately 1.0 foot. The soil sample collected at this level showed 4,300 $\mu\text{g/g}$; samples collected at lower depths (below the water table) showed less than 50 $\mu\text{g/g}$ (7.0 to 8.0 feet) and 280 $\mu\text{g/g}$ (10.0 to 11.0 feet).

Test Boring TB-10 was advanced to a depth of 8.0 feet, and four samples were collected for analysis. Only one of these samples, 3.0 to 4.0 feet, showed any detectable O/G (110 $\mu\text{g/g}$). Data presented by this boring in conjunction with Test Pit TP-3 indicate the northern limit of the area of O/G contamination as shown in Figure 6.

Borings TB-8 and TB-9 were placed upgradient of the discharge point for the 12-inch drain pipe from the oil unloading platform area. Because free product was found at this boring location, it appears that surface

spillage of product in the oil unloading platform area, rather than the pipe discharge, is the source of the encountered O/G.

Four shallow (less than 1.0 foot) test pits were then excavated to determine the northern limit of free product on the aquifer (Figure 2). Test Pits TP-1, TP-2, and TP-4 were each found to show evidence of free oil. The oil located in this area was thick and heavy compared to the relatively thin oil found in Boring TB-7, TB-8, and TB-9. A sample of this oil was collected at TP-1 and analyzed for EP toxicity chromium and lead and found to have no detectable trace of either metal (Table 2).

4.0 PROPOSED CORRECTIVE MEASURES

This chapter discusses the proposed corrective measures to address the accumulation of minor amounts of free product on top of the aquifer at the oil unloading platform area.

4.1 WORK PLAN

4.1.1 Well Installation

Remcor will subcontract a local drilling company to mobilize to the Armco site for installation of one 6-inch diameter recovery well and two 6-inch diameter oil detecting wells. These detection wells could later be fitted with oil recovery pump systems if testing indicates recovery is required at these locations. Figure 7 shows the proposed locations of these wells based on the data available from this investigation.

The recovery well will be constructed of 6-inch polyvinyl chloride (PVC) continuous wrapped screen not less than 0.020-inch slot. The pumping well will be drilled to a depth of approximately 8 to 10 feet below the water table to facilitate the ground water table depression. The 6-inch oil detecting wells will be located 80 to 100 feet north and south of the pumping well and constructed similar to the pumping well with 1-inch PVC inner pipes similar to the in-place oil detecting piezometer (Appendix C). This method provides wells suitable for product recovery (should they become necessary) without incurring an additional drilling program. Fitting of these wells with a 1-inch PVC drop-pipe will not preclude their use as pumping wells because the pumps intended for use are designed for use in 4-inch diameter wells.

The pumping well will be outfitted with a pump specifically designed for recovery of floating product by pumpage of total fluids. The pump system will be fitted with a control panel to provide either automated or manual control to allow continuous pumping. Since drawing the water level down below the intake of the pump may result in damage to the system, the automated operation mode will be a desirable feature.

4.1.2 Pumping Tests

After installation of the system, the on-site Remcor geologist will initiate a pumping test to establish the optimum pumping rate. The effects of the system will be monitored at the monitoring points established by the two additional six-inch wells to the north and south and the in-place oil detecting piezometer to the east. Water levels, drawdown, and change in oil thickness will each be monitored in the observation wells during pumping of the recovery well. Because the permeability and transmissivity of the aquifer have not yet been defined; at this time, estimates of pumping rates are preliminary. It is expected that pumping rates will be on the order of 3 to 5 gpm. The installation of the observation wells will provide data on cone of depression created by pumping. At this time, it is anticipated that the pump shutoff switch will be located at the level of the bottom of the fill materials.

4.1.3 Operations

The collected oil product and associated ground water will be piped into Armco's wastewater treatment system. Access to this system will be provided at the nearby overhead pipeline. The treatment system currently handles a flow of approximately 18,000 gpm; the estimated increase to this system as a result of pumping the recovery well is estimated to be well less than 10 gpm. In the event the additional two wells would be needed for recovery, each would contribute an additional flow less than 10 gpm.

The pumping well will be monitored during this process by use of an in-line continuous recording flow meter. This meter will be left in-line at the completion of the pumping test to monitor total fluid pumped from the well during periods in which the pump is in the automatic mode. Meter readings will be made at least twice a week during a three-month period subsequent to the initial pumping.

4.2 PROJECT SCHEDULE

Remcor is prepared to mobilize within two weeks of project approval. The drilling phase of this project is anticipated to require one week to

complete. The pilot pumping of the system will commence approximately three to four days after the drilling to provide time for installation of the pumping system and allow each of the wells to come to static conditions. Pumping of the recovery well will be conducted at various discharge rates over a period of one week to make a preliminary assessment of the system's operational effectiveness. The system will be operated for a period of three months, at which time the accumulated oil in nearby observation wells will again be evaluated. At this time, a decision will be made to take one of the following courses of action:

- Permit the system to continue operation as originally set up
- Modify the pumping rate and/or intake elevation in the pumping well
- Install additional recovery pumps at the six-inch monitoring wells
- Determine if product recovery is completed and discontinue pumping at the recovery well.

If product recovery appears to be complete, the pump will be shut down for a period of three months to determine whether additional oil accumulates in the recovery well. If no measurable oil accumulates in the well after this time period, the corrective measures will be considered complete.

4.3 AGENCY PROGRESS REPORTS

Remcor suggests that a letter of project progress will be submitted to the MDNR at the completion of the first three-month period of pumping. This letter would address the findings of the pilot pumping and notify the MDNR of Armco's selected course of action at completion of this pumping.

TABLE 1
SAMPLE ANALYSIS SUMMARY
U.S. ARMY CORPS OF ENGINEERS BLUE RIVER BANK SOIL SAMPLES

SAMPLE IDENTIFICATION ⁽⁵⁾	DATE	DETECTED OIL TYPE	pH (su) ⁽⁶⁾	VOC ⁽¹⁾ (mg/kg) ⁽⁷⁾	PCB ⁽²⁾ (mg/kg)	TRPH ⁽³⁾ (mg/kg)	(O/G) ⁽⁴⁾ (mg/kg)
UD521 J4	11/12/88	MW Oil ⁽⁸⁾	10.5	NA ⁽⁹⁾	<1	580	756
UD520-IV	11/30/88	MW Oil	NA	<1	<1	577	661
UD520-2	11/30/88	NA	NA	NA	<1	NA	NA
I-520 7+	11/30/88	MW Oil	7.96	<1	<1	511	701
I-520 9+	12/05/88	MW and No. 6 ⁽¹⁰⁾	7.28	<1	<1	248	366
I-520 10+	12/05/88	MW Oil	7.54	12.5 ⁽¹¹⁾	<1	827	996
I-520 12+	12/05/88	MW and No. 2 ⁽¹²⁾	7.54	<1	<1	207	303
I-520 13+	12/05/88	MW Oil	7.31	<1	<1	161	240
D522-0	01/03/89	No. 6 Oil	NA	NA	NA	406	728
D523-0	01/03/89	No. 6 Oil	NA	NA	NA	3,176	5,124
D524-1	12/29/88	No. 6 Oil	NA	NA	NA	540	1,097
D524-3	12/29/88	No. 6 Oil ^{*(13)}	NA	NA	NA	227	362
D524-6	12/29/88	No. 6 Oil	NA	NA	NA	238	394
D524-13	12/29/88	No. 6 Oil*	NA	NA	NA	84	178

See footnotes at end of table.

TABLE 1
(Continued)

SAMPLE IDENTIFICATION ⁽⁵⁾	DATE	DETECTED OIL TYPE	pH (su) ⁽⁶⁾	VOC ⁽¹⁾ (mg/kg) ⁽⁷⁾	PCB ⁽²⁾ (mg/kg)	TRPH ⁽³⁾ (mg/kg)	(O/G) ⁽⁴⁾ (mg/kg)
D525-0	12/30/88	No. 6 Oil*	NA	NA	NA	1,171	1,716
D525-3	12/30/88	No. 6 Oil*	NA	NA	NA	8,728	9,509
D525-6	12/30/88	No. 6 Oil	NA	NA	NA	6,052	7,972
D525-9	12/30/88	No. 6 Oil	NA	NA	NA	226	334
D525-14	12/30/88	No. 6 Oil	NA	NA	NA	251	382
D526-3	01/03/89	No. 6 Oil	NA	NA	NA	5,953	6,100
D526-12	01/03/89	No. 6 Oil	NA	NA	NA	175	276
D527-0	01/10/89	No. 6 Oil	NA	NA	NA	269	457
D527-2	01/10/89	No. 6 Oil*	NA	NA	NA	274	530
D527-4	01/10/89	No. 6 Oil	NA	NA	NA	265	462
D527-6	01/10/89	No. 6 Oil*	NA	NA	NA	420	729
D527-8	01/10/89	No. 6 Oil*	NA	NA	NA	BDL ⁽¹⁴⁾	76
D527-10	01/10/89	No. 6 Oil*	NA	NA	NA	420	729
D527-14	01/10/89	ND	NA	NA	NA	474	1,073
D528-2	01/09/89	No. 6 Oil*	NA	NA	NA	321	573
D528-5	01/09/89	No. 6 Oil*	NA	NA	NA	96	301
D528-6	01/09/89	No. 6 Oil*	NA	NA	NA	123	294
D528-8	01/09/89	No. 6 Oil*	NA	NA	NA	38	168

See footnotes at end of table.

TABLE 1
(Continued)

SAMPLE IDENTIFICATION ⁽⁵⁾	DATE	DETECTED OIL TYPE	pH (su) ⁽⁶⁾	VOC ⁽¹⁾ (mg/kg) ⁽⁷⁾	PCB ⁽²⁾ (mg/kg)	TRPH ⁽³⁾ (mg/kg)	(O/G) ⁽⁴⁾ (mg/kg)
D529-4	01/10/89	No. 6 Oil	NA	NA	NA	138	452
D529-6	01/10/89	No. 6 Oil*	NA	NA	NA	347	864
D530-2	01/10/89	No. 6 Oil*	NA	NA	NA	546	1,383
D530-4	01/10/89	No. 6 Oil	NA	NA	NA	484	1,048
D530-6	01/10/89	No. 6 Oil*	NA	NA	NA	489	926
D530-9	01/10/89	No. 6 Oil*	NA	NA	NA	395	903

- (1)"VOC" indicates volatile organic compound.
- (2)"PCB" indicates polychlorinated biphenyl.
- (3)"TRPH" indicates total recoverable petroleum hydrocarbon.
- (4)"O/G" indicates oil and grease.
- (5) Sample identification indicates boring number and sample depth.
- (6)"su" indicates standard units of pH measurements.
- (7)"mg/kg" indicates milligrams per kilogram.
- (8) MW Oil indicates medium weight oil.
- (9)"NA" indicates not analyzed.
- (10) No. 6 indicates No. 6 fuel oil.
- (11)"12.5" indicates source compound(s) could not be positively identified; 71 percent probability the compound is 4, 7-methano - 1H - indene, 3a, 4, 7, 7a - tetrahydro (TetrahydroMethaneIndene); chloromethane detected at 133.6 micrograms per kilogram (µg/kg); xylene detected at 84 µg/kg.
- (12) No. 2 indicates No. 2 fuel oil.
- (13)"*" indicates weathered.
- (14)"BDL" indicates below detection limits.

TABLE 2
SOIL SAMPLE RESULTS
ABOVEGROUND OIL STORAGE TANK AREA

SAMPLE NUMBER	BORING	DEPTH (feet)	MATERIAL	ABOVE WATER TABLE	AT WATER TABLE	BELOW WATER TABLE	O/G ⁽¹⁾ (µg/g) ⁽²⁾	EP TOX CHROMIUM (mg/l) ⁽³⁾	EP TOX LEAD (mg/l)	pH SOIL (su) ⁽⁴⁾
RKO-TB1A-1	TB-1A	0.0-0.8	Mill scale fill	X			7,700			
RKO-TB1B-2	TB-1B	8.0-9.0	Green sand fill	X			63			
RKO-TB1B-3	TB-1B	10.0-11.0	Dense slag fill		X		2,300	<0.1 ⁽⁵⁾	0.1	10.35
RKO-TB1B-4	TB-1B	13.0-15.0	Dense slag fill			X	95			
RKO-TB1B-5	TB-1B	18.5-19.0	Gray silty clay			X	53			
RKO-TB2B-1	TB-28	3.0-4.0	Dense slag fill	X			200			
RKO-TB2D-2	TB-2D	10.0-11.0	Dense slag fill			X	100	<0.1	0.4	9.95
RKO-TB4-1	TB-4	4.0-5.0	Green sand fill	X			140			
RKO-TB5-1	TB-5	4.0-5.0	Gray silty sand	X			<50	<0.1	<0.1	8.35
RKO-TB5-2	TB-5	6.0-7.0	Gray clayey silt		X		110			
RKO-TB5-3	TB-5	11.0-12.0	Gray silty clay			X	100			
RKO-TB6-1	TB-6	0.5-1.5	Brown silty sand	X			75			
RKO-TB6-2	TB-6	5.0-6.0	Gray sandy silt		X		<50	<0.1	0.1	7.90
RKO-TB6-3	TB-6	7.0-8.0	Gray sandy silt			X	100/88 ⁽⁶⁾			
RKO-TB6-4	TB-6	9.0-10.0	Gray sandy silt			X	480			
RKO-TB7-1	TB-7	1.0-2.0	Brown silty sand	X			77			
RKO-TB7-2	TB-7	4.0-5.0	Brown sandy silt			X	370	<0.1	0.1	8.20
RKO-TB7-3	TB-7	7.0-8.0	Gray silty sand			X	78			
RKO-TB8-1	TB-8	1.0-2.0	Scale/slag fill	X			530			
RKO-TB8-2	TB-8	4.0-6.0	Scale/slag fill		X		4,000	<0.1	<0.1	7.30

See footnotes at end of table.

TABLE 2
(Continued)

SAMPLE NUMBER	BORING	DEPTH (feet)	MATERIAL	ABOVE WATER TABLE	AT WATER TABLE	BELOW WATER TABLE	O/G ⁽¹⁾ ($\mu\text{g/g}$) ⁽²⁾	EP TOX CHROMIUM (mg/l) ⁽³⁾	EP TOX LEAD (mg/l)	pH SOIL (su) ⁽⁴⁾
RKO-TB8-3	TB-8	9.0-10.0	Gray sandy silt			X	<50			
RKO-TB8-4	TB-8	11.0-12.0	Gray sandy silt			X	<50			
RKO-TB9-1	TB-9	1.0-2.0	Slag/clay fill		X		4,300	<0.1	0.3	10.50
RKO-TB9-2	TB-9	7.0-8.0	Gray sandy silt			X	<50			
RKO-TB9-3	TB-9	10.0-11.0	Gray sandy silt			X	280			
RKO-TB10-1	TB-10	1.0-2.0	Gray sandy silt		X		<50	<0.1	<0.1	10.00
RKO-TB10-2	TB-10	3.0-4.0	Gray sandy silt			X	110			
RKO-TB10-3	TB-10	5.0-6.0	Gray sandy silt			X	<50/<50			
RKO-TB10-4	TB-10	7.0-8.0	Gray silt			X	<50			
RKO-TB11-1	TB-11A	4.5-5.0	Dense slag fill	X			170			
RKO-TB11-2	TB-11B	3.0-4.5	Dense slag fill	X			110			
RKO-TB12-1	TB-12	6.0-9.0	Dense slag fill	X			2,500			
RKO-TP-01	TP-1	Surface	Oil sample	X				<0.1	<0.1	6.00

(1) O/G = oil/grease

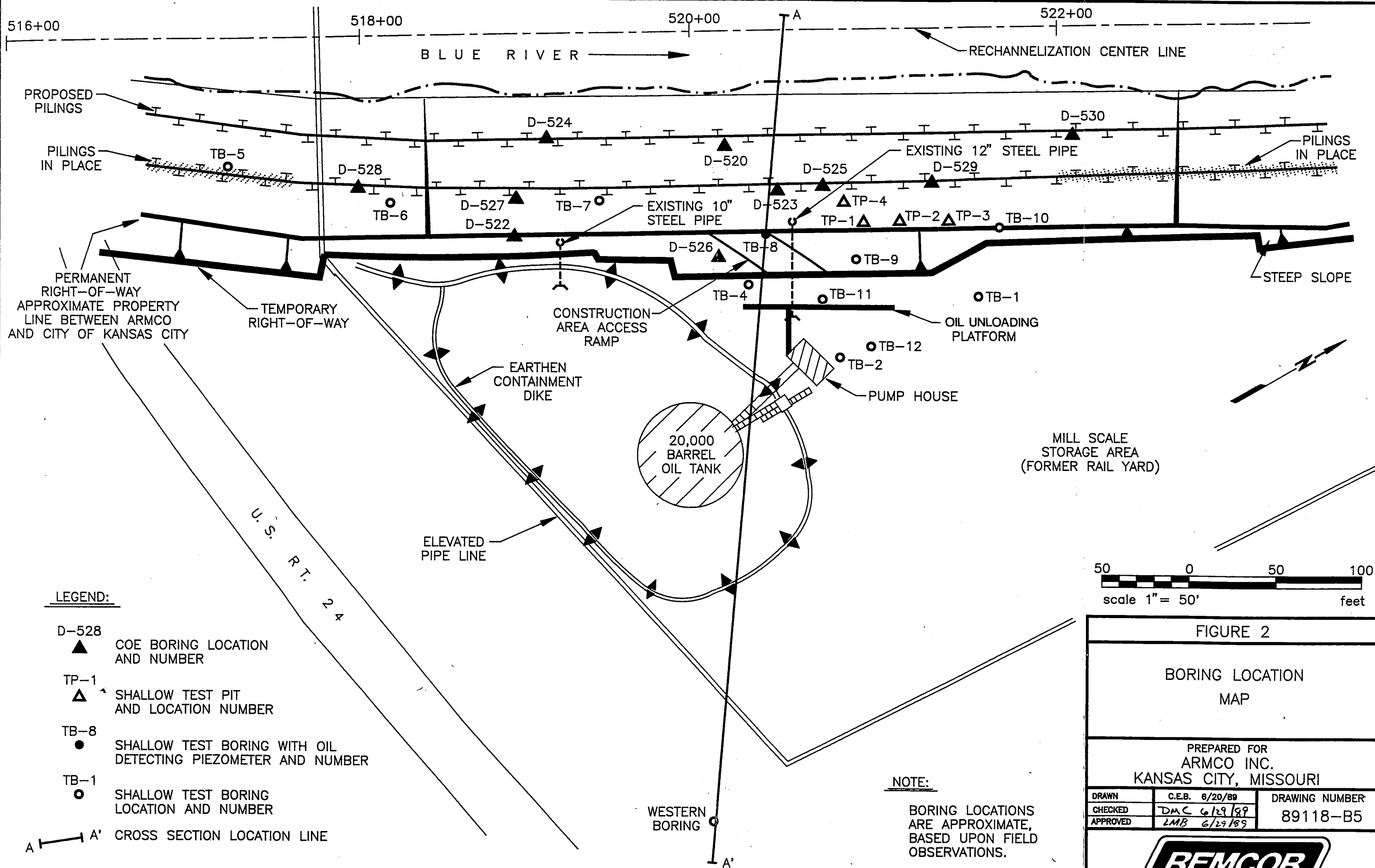
(2) $\mu\text{g/g}$ = microgram/gram

(3) mg/l = milligram/liter

(4) su = standard units of pH measurement

(5) <0.1 = less than detection level

(6) // = sample analyzed in duplicate



- LEGEND:**
- D-528 COE BORING LOCATION AND NUMBER
 - TP-1 SHALLOW TEST PIT AND LOCATION NUMBER
 - TB-8 SHALLOW TEST BORING WITH OIL DETECTING PIEZOMETER AND NUMBER
 - TB-1 SHALLOW TEST BORING LOCATION AND NUMBER
 - A — A' CROSS SECTION LOCATION LINE



NOTE:
BORING LOCATIONS ARE APPROXIMATE, BASED UPON FIELD OBSERVATIONS.

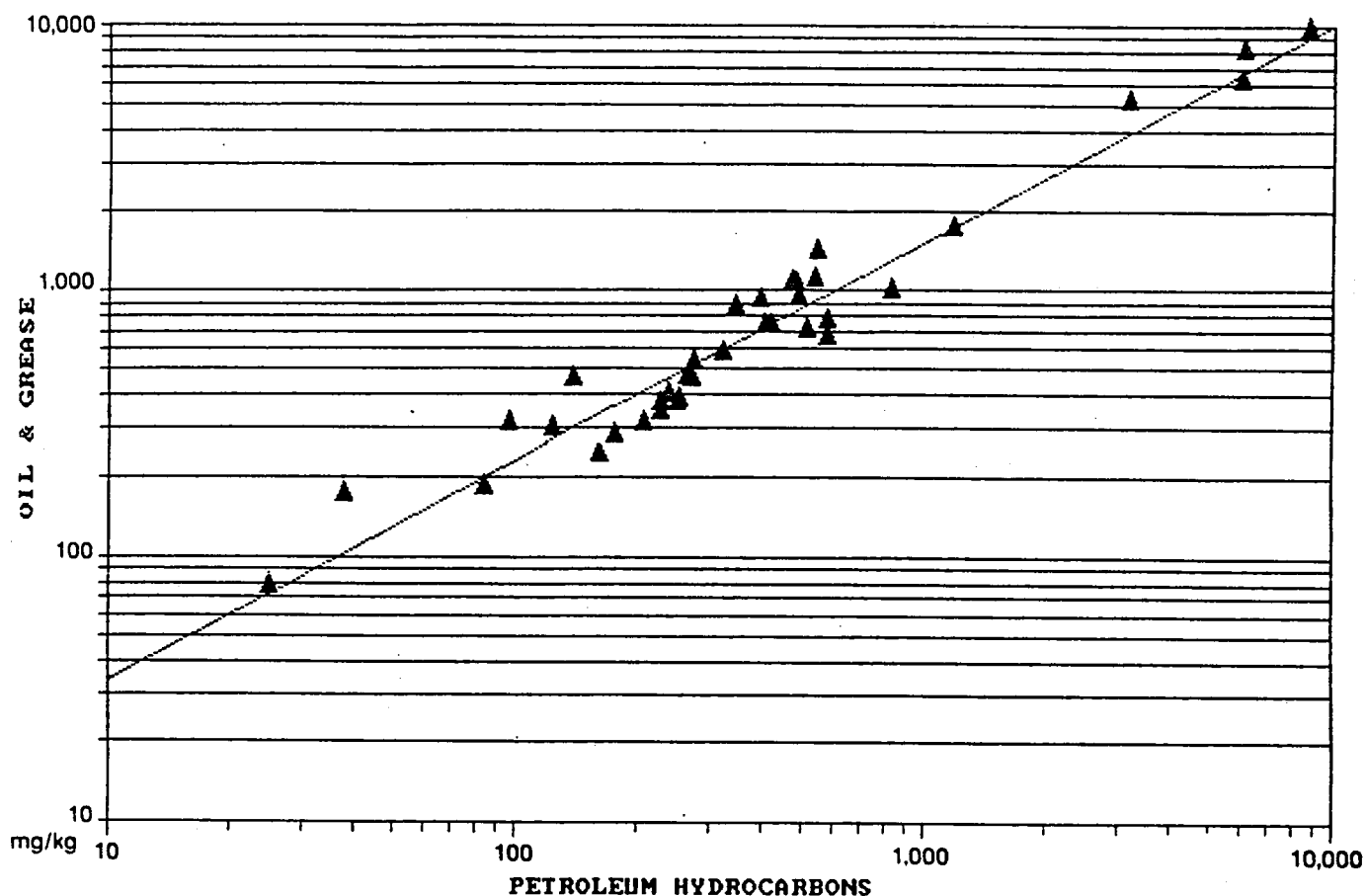
FIGURE 2

BORING LOCATION MAP

PREPARED FOR
ARMCO INC.
KANSAS CITY, MISSOURI

DRAWN	C.E.B. 6/20/89	DRAWING NUMBER
CHECKED	DMC 6/29/89	89118-B5
APPROVED	LMB 6/29/89	

REMCOR



THE REGRESSION POLYNOMIAL OF LINE 1 -

$$(7.068E-01) + (8.246E-01)X$$

THE VARIANCE - $1.048E-02$

NOTE:

SAMPLES COLLECTED BY ARMY CORPS
OF ENGINEERS DURING PERIOD
NOVEMBER 1988 TO MARCH 1989.

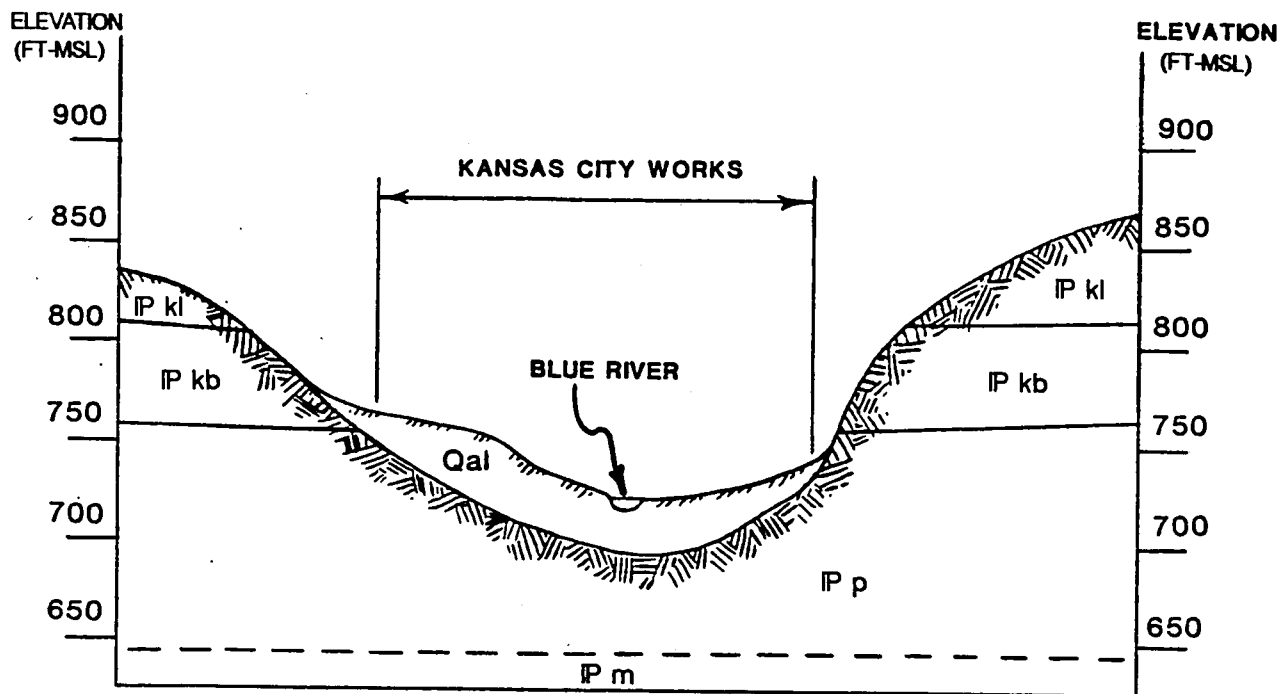
FIGURE 3

TOTAL PETROLEUM HYDROCARBON
VS. OIL & GREASE
RELATIONSHIP

PREPARED FOR
ARMCO INC.
KANSAS CITY, MISSOURI

DRAWN	C.E.B. 6/20/89	DRAWING NUMBER 89118-A3
CHECKED	DMC 6/29/89	
APPROVED	LMB 6/29/89	

REMCOR



SCALE:

HORIZ. 1" = 3000'

VERT. 1" = 100'

(VERTICAL EXAGGERATION = 30X)

LEGEND

QUATERNARY SYSTEM

Qal - BLUE RIVER ALLOUVIUM -ALLOVIAL SAND, SILT, AND GRAVEL

PENNSYLVANIAN SYSTEM

MISSOURIAN SERIES

IPkl - KANSAS CITY GROUP LINN SUBGROUP -PREDOMINANTLY SHALES WITH A FEW PERSISTANT LIMESTONES AND SOME THIN SANDSTONES

IPkb - KANSAS CITY GROUP BRONSON SUBGROUP -CYCLIC SEQUENCE OF THREE LIMESTONE FORMATIONS AND TWO SHALE-CLAY UNITS

IPp - PLEASANTON GROUP -ARGILLACEOUS TO SANDY, MICACEOUS SHALE AND FOSSILIFEROUS SILTSTONE

IPm - MARMATON GROUP -SLEALE, LIMESTONE, SANDSTONE

REF: GEOLOGIC MAP OF INDEPENDENCE QUADRANGLE, JACKSON COUNTY, MISSOURI BY E. J. PARIZER, 1968

FIGURE 4

**GENERALIZED GEOLOGIC
CROSS SECTION**

**PREPARED FOR
ARMCO INC.**

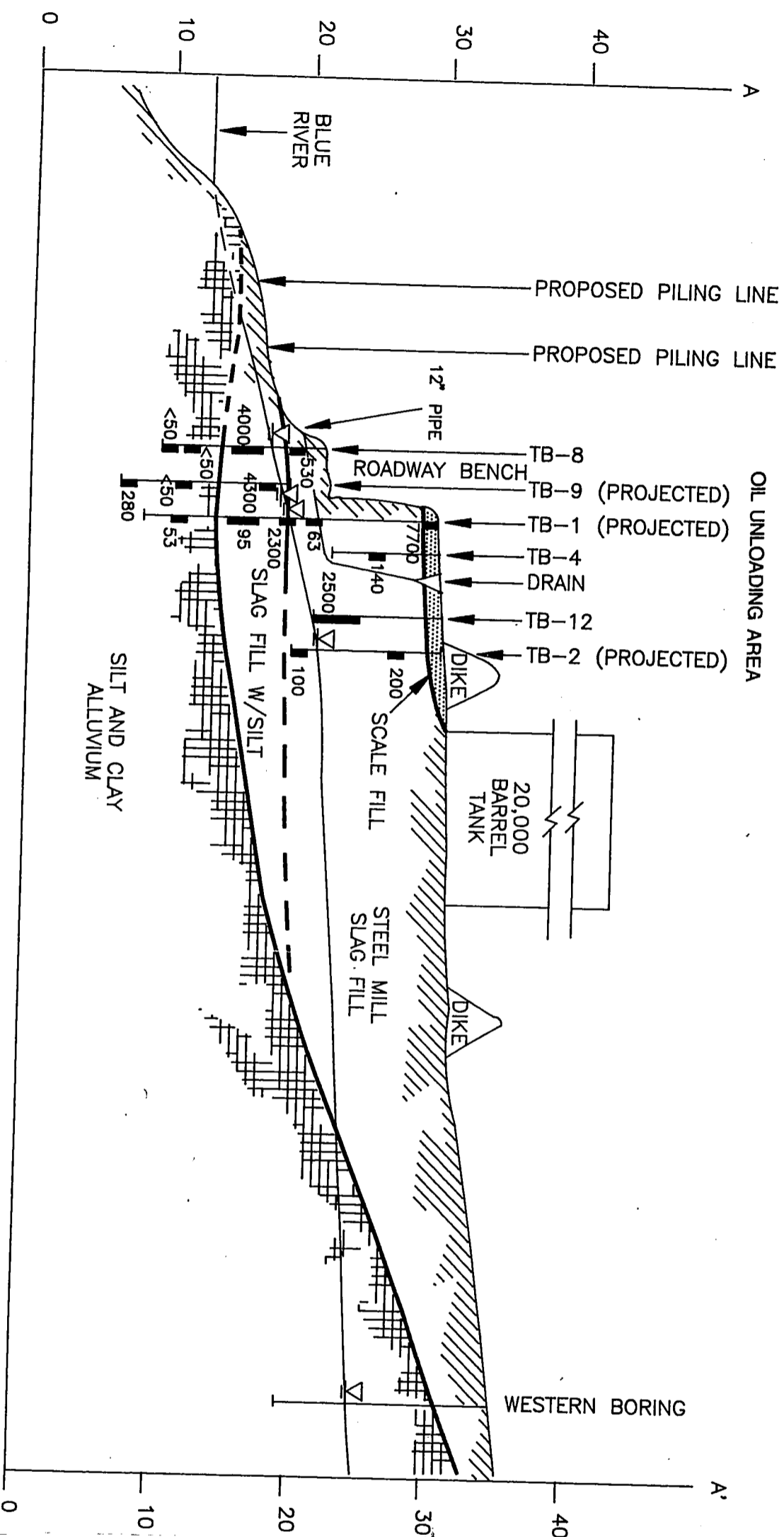
KANSAS CITY, MISSOURI

DRAWN	C.E.B. 6/20/89
CHECKED	DMC 6/29/89
APPROVED	UMB 6/29/89

DRAWING NUMBER

89118-A4

REMCOR



ELEVATION
ABOVE ARBITRARY
DATUM (FEET)



FIGURE 5

GEOLOGIC
CROSS-SECTION A-A'

PREPARED FOR
ARMCO INC.
KANSAS CITY, MISSOURI

DRAWN	L.B.L. 6/21/89	DRAWING NUMBER
CHECKED	D.M.C. 6/29/89	89118-B8
APPROVED	L.M.B. 6/29/89	

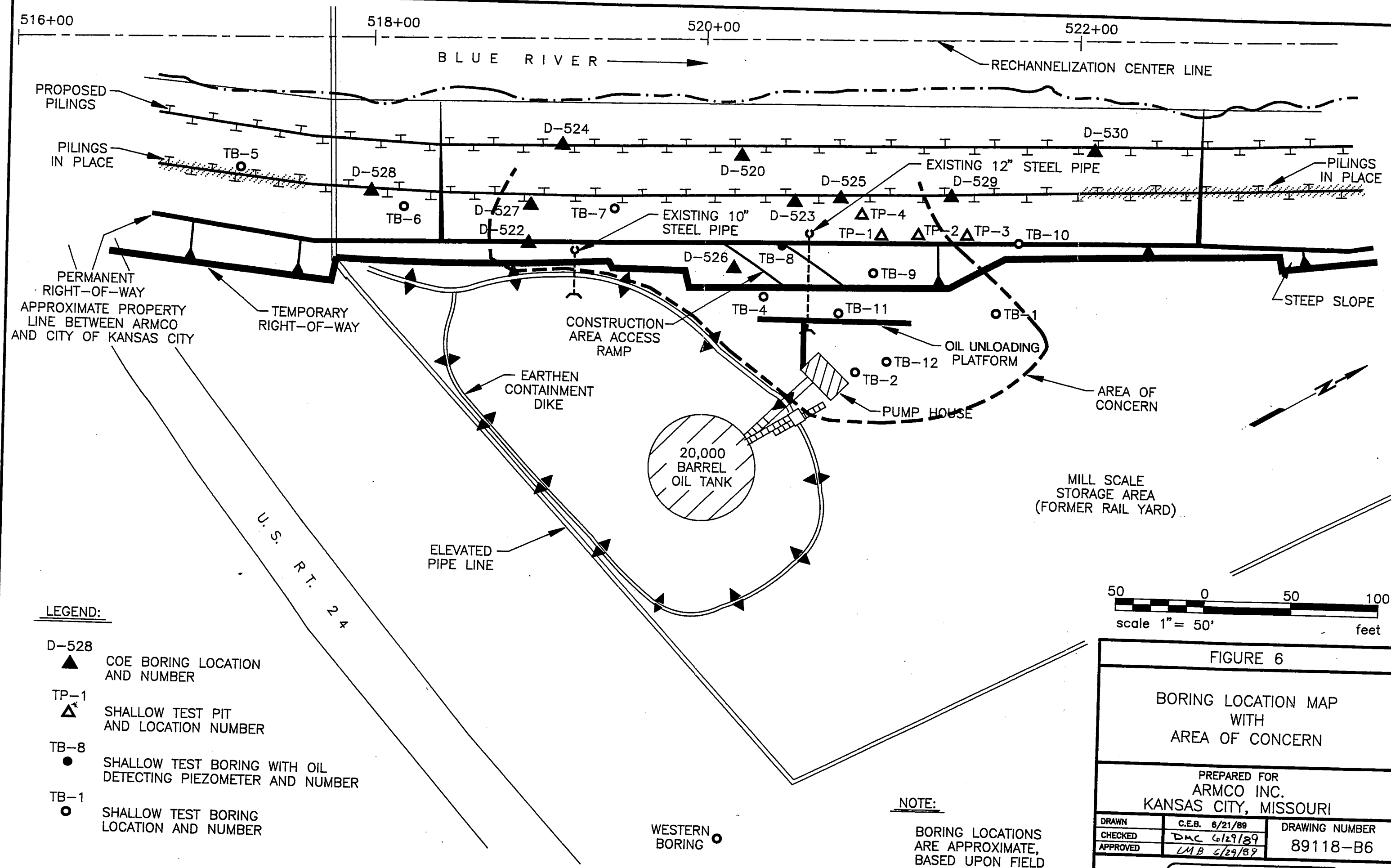
REMCO

LEGEND:

- TB-4 = BORING NUMBER
- 200 = SAMPLE LOCATION AND OIL/GREASE CONCENTRATION
- ▽ = GROUND WATER
- = DEPTH OF BORING

NOTES:

- 1: SEE FIGURE 1 FOR CROSS SECTION LOCATION.
- 2: TOPOGRAPHY IS APPROXIMATE, BASED ON FIELD OBSERVATIONS AND U.S. ARMY CORPS OF ENGINEERS RECHANNELIZATION DESIGN DRAWINGS.
- 3: ELEVATION OF BLUE RIVER STAGE IS APPROXIMATE.



LEGEND:

- D-528
▲ COE BORING LOCATION AND NUMBER
- TP-1
▲ SHALLOW TEST PIT AND LOCATION NUMBER
- TB-8
● SHALLOW TEST BORING WITH OIL DETECTING PIEZOMETER AND NUMBER
- TB-1
○ SHALLOW TEST BORING LOCATION AND NUMBER

NOTE:

BORING LOCATIONS ARE APPROXIMATE, BASED UPON FIELD OBSERVATIONS.



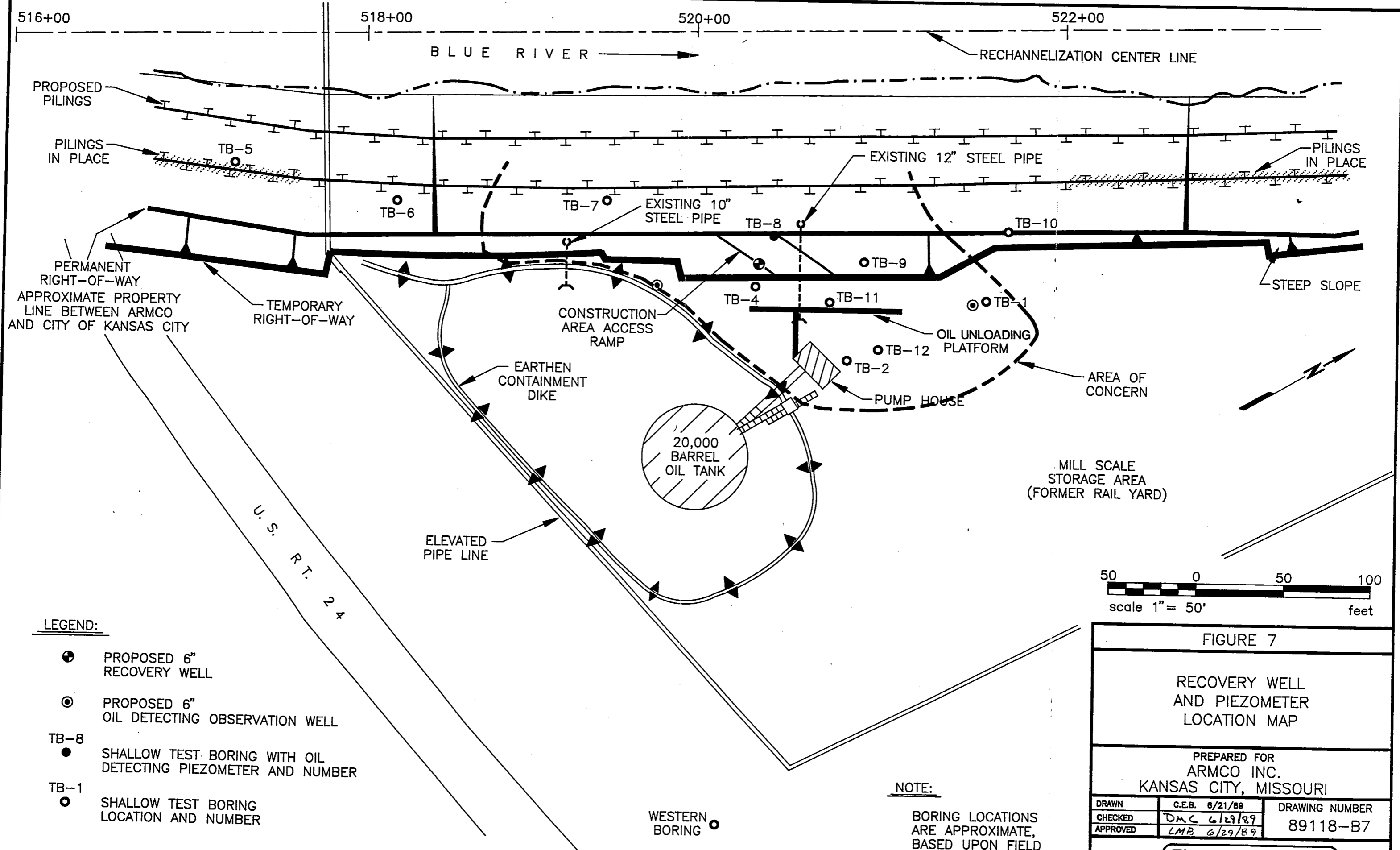
FIGURE 6

BORING LOCATION MAP WITH AREA OF CONCERN

PREPARED FOR
ARMCO INC.
KANSAS CITY, MISSOURI

DRAWN	C.E.B. 6/21/89	DRAWING NUMBER 89118-B6
CHECKED	DMC 6/29/89	
APPROVED	LMB 6/29/89	

REMCOR



LEGEND:

- ⊕ PROPOSED 6" RECOVERY WELL
- ⊙ PROPOSED 6" OIL DETECTING OBSERVATION WELL
- TB-8 ● SHALLOW TEST BORING WITH OIL DETECTING PIEZOMETER AND NUMBER
- TB-1 ○ SHALLOW TEST BORING LOCATION AND NUMBER

NOTE:

BORING LOCATIONS ARE APPROXIMATE, BASED UPON FIELD OBSERVATIONS.

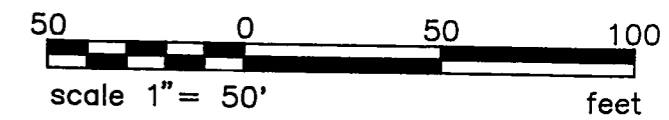


FIGURE 7		
RECOVERY WELL AND PIEZOMETER LOCATION MAP		
PREPARED FOR ARMCO INC. KANSAS CITY, MISSOURI		
DRAWN C.E.B. 6/21/89	CHECKED D.M.C. 6/29/89	DRAWING NUMBER 89118-B7
APPROVED L.M.B. 6/29/89		

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APPENDIX A
U.S. ARMY CORPS OF ENGINEERS LABORATORY
REPORT FOR ORGANICS;
SAMPLE I-520, 10.5' TO 12.0'

ENVIRONMENTAL HEALTH RESEARCH AND TESTING, INC.
RESULT SHEET

CUSTOMER NAME: U.S. ARMY CORPS OF ENGINEERS
SAMPLE SOURCE: BLUE RIVER CHANNEL - DR. JOE SOLSKY
WORK ORDER NO.: 240 PROJECT NO.: 10211
SAMPLE TYPE: SOIL SAMPLE METHOD NO.: EPA 8270
ANALYSIS PERFORMED: GC/MS Analysis for B/N/A
EXTRACTED: 12-12-88 ANALYZED: 12-13-88
ANALYST: L. Davidson, Ph.D. LAB NOTEBOOK NO.: 90, Pg. 98
CUSTOMER SAMPLE NO.: I-520, 10.5'-12.0' (881206-003) EHRT NO.: 15511

RESULTS (mg/kg)

2-Picoline - BDL	Methyl Methanesulfonate - BDL
Ethyl Methanesulfonate - BDL	Aniline - BDL
Benzyl Alcohol - BDL	Bis(2-Chloroethyl)Ether - BDL
1,3-Dichlorobenzene - BDL	1,4-Dichlorobenzene - BDL
1,2-Dichlorobenzene - BDL	Bis(2-Chloroisopropyl)Ether - BDL
N-Nitrosodimethylamine - BDL	N(Nitrosodi-N-Propylamine) - BDL
Acetophenone - BDL	Hexachloroethane - BDL
Nitrobenzene - BDL	Isophorone - BDL*
Bis(2-Chloroethoxy)Methane - BDL*	Benzoic Acid - 50.75
a-,a-Dimethylphenethylamine - BDL	1,2,4-Trichlorobenzene - BDL
Naphthalene - 12.88	Hexachlorobutadiene - BDL
N-Nitroso-di-n-butylamine - BDL	2-Methylnaphthalene - 17.53
Hexachlorocyclopentadiene - BDL	2-Chloronaphthalene - BDL*
1-Chloronaphthalene - BDL	2-Nitroaniline - BDL
Dimethylphthalate - BDL	Acenaphthylene - BDL*
Acenaphthene - 1.14	Pentachloronitrobenzene - BDL
1,2,4,5-Tetrachlorobenzene - BDL	3-Nitroaniline - BDL
4-Nitroaniline - BDL	2,4-Dinitrotoluene - BDL
4-Chloroaniline - BDL	Endrin Ketone - BDL

C22

ENVIRONMENTAL HEALTH RESEARCH AND TESTING, INC.
RESULT SHEET

CUSTOMER NAME: U.S. ARMY CORPS OF ENGINEERS
SAMPLE SOURCE: BLUE RIVER CHANNEL - DR. JOE SOLSKY
WORK ORDER NO.: 240 PROJECT NO.: 10211
SAMPLE TYPE: SOIL SAMPLE METHOD NO.: EPA 8270
ANALYSIS PERFORMED: GC/MS Analysis for B/N/A
EXTRACTED: 12-12-88 ANALYZED: 12-13-88
ANALYST: L. Davidson, Ph.D. LAB NOTEBOOK NO.: 90, Pg. 98
CUSTOMER SAMPLE NO.: I-520, 10.5'-12.0' (881206-003) EHRT NO.: 15511

RESULTS (mg/kg)

2,6-Dinitrotoluene - BDL	Dibenzofuran - BDL*
Diethylphthalate - BDL	1-Naphthylamine - BDL
2-Naphthylamine - BDL	4-Chlorophenyl-Phenyl-Ether - BDL
Fluorene - 0.68	N-Nitrosodiphenylamine - BDL
Diphenylamine - BDL	1,2-Diphenylhydrazine - BDL
N-Nitrosopiperidine - BDL	4-Bromophenyl-Phenyl-Ether - BDL
4-Aminobiphenyl - BDL	Hexachlorobenzene - BDL
Pentachlorobenzene - BDL	Phenacetin - BDL
Pronamide - BDL	Phenanthrene - 3.94
Anthracene - BDL*	Alpha-BHC - BDL
Beta-BHC - BDL	Gamma-BHC (Lindane) - BDL
Delta-BHC - BDL	Heptachlor - BDL
Aldrin - BDL	Di-n-Butylphthalate - BDL
Heptachlor Epoxide - BDL	Endosulfan I - BDL
Fluoranthene - BDL	Dieldrin - BDL
4,4'-DDE - BDL	Benzidine - BDL
Pyrene - BDL*	Endrin - BDL
Endosulfan II - BDL	4,4'-DDD - BDL

C2

ENVIRONMENTAL HEALTH RESEARCH AND TESTING, INC.
RESULT SHEET

CUSTOMER NAME: U.S. ARMY CORPS OF ENGINEERS
SAMPLE SOURCE: BLUE RIVER CHANNEL - DR. JOE SOLSKY
WORK ORDER NO.: 240 PROJECT NO.: 10211
SAMPLE TYPE: SOIL SAMPLE METHOD NO.: EPA 8270
ANALYSIS PERFORMED: GC/MS Analysis for B/N/A
EXTRACTED: 12-12-88 ANALYZED: 12-13-88
ANALYST: L. Davidson, Ph.D. LAB NOTEBOOK NO.: 90, Pg. 98
CUSTOMER SAMPLE NO.: I-520, 10.5'-12.0' (881206-003) EHRT NO.: 15511

RESULTS (mg/kg)

p-Dimethylaminoazobenzene - BDL	Butyl-Benzyl-Phthalate - BDL
3,3'-Dichlorobenzidine - BDL	Benzo(a)Anthracene - BDL
Bis(2-Ethyl-Hexyl)Phthalate - BDL	Chrysene - BDL
7,12-Dimethylbenz(a)anthracene - BDL	4,4'-DDD - BDL
Endosulfan Sulfate - BDL	Endrin Aldehyde - BDL
3-Methylcholanthrene - BDL	Di-n-Octylphthalate - BDL
Benzo(b)Fluoranthene - BDL	Benzo(k)Fluoranthene - BDL
Benzo(a)Pyrene - BDL	Dibenz(a,j)Acridine - BDL
Indeno(1,2,3-c,d)Pyrene - BDL	Dibenzo(a,h)Anthracene - BDL
Benzo(g,h,i)Perylene - BDL	

*BDL - Compound detected in trace amount, too low to be accurately measured.

COMPUTER SEARCH:

1-Methylnaphthalene = Approximately 14.90 mg/kg

ENVIRONMENTAL HEALTH RESEARCH AND TESTING, INC.
RESULT SHEET

CUSTOMER NAME: U.S. ARMY CORPS OF ENGINEERS
 SAMPLE SOURCE: BLUE RIVER CHANNEL - DR. JOE SOLSKY
 WORK ORDER NO.: 240 PROJECT NO.: 10211
 SAMPLE TYPE: SOIL SAMPLE METHOD NO.: EPA 8270
 ANALYSIS PERFORMED: GC/MS Analysis for Acids
 EXTRACTED: 12-12-88 ANALYZED: 12-13-88
 ANALYST: L. Davidson, Ph.D. LAB NOTEBOOK NO.: 90, Pg. 98
 CUSTOMER SAMPLE NO.: I-520, 10.5'-12.0' (881206-003) EHRT NO.: 15511

RESULTS (mg/kg)

Phenol - BDL	2-Chlorophenol - BDL
2-Methylphenol - BDL	4-Methylphenol - BDL
2-Nitrophenol - BDL	2,4-Dimethylphenol - BDL
2,4-Dichlorophenol - BDL	2,6-Dichlorophenol - BDL
4-Chloro-3-Methyl Phenol - BDL	2,4,6-Trichlorophenol - BDL
2,4,5-Trichlorophenol - BDL	2,4-Dinitrophenol - BDL
4-Nitrophenol - BDL	2,3,4,6-Tetrachlorophenol - BDL
4,6-Dinitro-2-Methyl Phenol - BDL	Pentachlorophenol - BDL

SURROGATE COMPOUND

PERCENT RECOVERY

Nitrobenzene-d ₅	93.22%
2-Fluorobiphenyl	113.67%
Terphenyl-d ₁₄	81.46%
Phenol-d ₆	83.82%
2-Fluorophenol	69.75%
2,4,6-Tribromophenol	37.43%

QUALITY CONTROL OFFICER: 

DATE: 12/13/88

ENVIRONMENTAL HEALTH RESEARCH AND TESTING, INC.
RESULT SHEET

CUSTOMER NAME: U.S. ARMY CORPS OF ENGINEERS
 SAMPLE SOURCE: BLUE RIVER CHANNEL - DR. JOE SOLSKY
 WORK ORDER NO.: 240 PROJECT NO.: 10211
 SAMPLE TYPE: SOIL SAMPLE DATE ANALYZED: 12-12-88
 ANALYSIS PERFORMED: Volatile Organics Analysis METHOD NO.: EPA 8240
 ANALYST: J. Tobler LAB NOTEBOOK NO.: 98, Pg. 11
 CUSTOMER SAMPLE NO.: I-520, 10.5'-12.0' (881206-003) EHRT NO.: 15511

RESULTS (ug/kg)

Chloromethane - 133.67	Bromomethane - BDL
Vinyl Chloride - BDL	Chloroethane - BDL
Methylene Chloride - BDL	Trichlorofluoromethane - BDL
1,1-Dichloroethylene - BDL	1,1-Dichloroethane - BDL
1,2-Dichloroethylene - BDL	Chloroform - BDL
1,2-Dichloroethane - BDL	1,1,1-Trichloroethane - BDL
Carbontetrachloride - BDL	Bromodichloromethane - BDL
1,2-Dichloropropane - BDL	Trans-1,3-Dichloropropene - BDL
Trichloroethylene - BDL	Cis-1,3-Dichloropropene - BDL
Benzene - BDL	Chlorodibromomethane - BDL
1,1,2-Trichloroethane - BDL	2-Chloroethylvinylether - BDL
Bromoform - BDL	1,1,2,2-Tetrachloroethane - BDL
Tetrachloroethylene - BDL	Toluene - BDL
Chlorobenzene - BDL	Ethylbenzene - BDL

SURROGATE STANDARDS - % RECOVERIES

1,2-Dichloroethane-d₄ - 81.1%
 Toluene-d₈ - 54.4%
 Bromofluorobenzene - 55.4%

C2

ENVIRONMENTAL HEALTH RESEARCH AND TESTING, INC.
RESULT SHEET

CUSTOMER NAME: U.S. ARMY CORPS OF ENGINEERS
SAMPLE SOURCE: BLUE RIVER CHANNEL - DR. JOE SOLSKY
WORK ORDER NO.: 240 PROJECT NO.: 10211
SAMPLE TYPE: SOIL SAMPLE DATE ANALYZED: 12-12-88
ANALYSIS PERFORMED: Volatile Organics Analysis METHOD NO.: EPA 8240
ANALYST: J. Tobler LAB NOTEBOOK NO.: 98, Pg. 11
CUSTOMER SAMPLE NO.: I-520, 10.5'-12.0' (881206-003) EHRT NO: 15511

RESULTS (ug/kg)

Acetone - BDL	Acrolein - BDL
Acrylonitrile - BDL	2-Butanone - BDL
Carbon Disulfide - BDL	Dibromomethane - BDL
1,4-Dichloro-2-Butene - BDL	Dichlorodifluoromethane - BDL
Ethanol - BDL	Ethylmethacrylate - BDL
2-Hexanone - BDL	Iodomethane - BDL
4-Methyl-2-Pentanone - BDL	Styrene - BDL
1,2,3-Trichloropropane - BDL	Vinyl Acetate - BDL
Xylene - 84	

COMPUTER SEARCH:

TetrahydroMethaneIndene = Approximately 12,000 ug/kg

DETECTION LIMIT: RAISED BY FACTOR OF 2.5

QUALITY CONTROL OFFICER: _____

DATE: 12/13/88

APPENDIX B
BORING LOGS



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO Rebores Oil Tank		
BORING NUMBER: TB-1	COORDINATES:		DATE: 5/5/89
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 5/1/89
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date/Time	DATE COMPLETED: 5/1/89
DRILLING METHODS: Hollow Stem Auger			PAGE 1 OF 1

DEPTH (Feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (Feet)	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5	S/1	166	70	LOOSE BLACK FINE MILL SCALE FILL			RKO-TB1A-1 ← AUGER REFUSAL @ TB1A
	S/2	236	50	VERY DENSE TAN/BROWN SLAG GRAVEL FILL; DRY			
	S/3	46	80	(LOOSE) GREEN COARSE SAND FILL DAMP, RESEMBLES OLIVINE			
10	S/4	42	50	DENSE BROWN FILL; SLAG TRACE MILL SCALE AND WEATHERED FIRE BRICK, WET			RKO-TB1B-2 WATER @ 10.5 RKO-TB1B-3 SLIGHT PHC ODOR SLIGHT PHC ODOR RKO-TB1B-4
	S/5	75	0				
	S/6	40	50				
15	S/7	6	25	SOFT DARK GRAY TO BLACK SILTY CLAY; SOME PLANT FRAGMENTS, DAMP	CL		slight PHC odor RKO-TB1B-5
	S/8	5	NR				
	S/9	6	0				
20				← Bottom of Boring 21.0'			

NOTES:

NR - indicates not recorded

This boring only reflects conditions encountered at Test Boring; TB1A
AND TB-1B AS A SINGLE boring; TB-1.



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO KC Works Oil Tank		
BORING NUMBER: TB-2	COORDINATES:		DATE: 5/9/89
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 5/2/89
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date/Time	DATE COMPLETED: 5/2/89
DRILLING METHODS: Hollow Stem Auger			PAGE 1 OF 1

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (Foot)	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	S 1	136	50	DENSE BLACK FINE MILLISEALE FILL			- TRACE OIL SHEEN
	S 2	133	65	VERY DENSE TAN BROWN FILL; CLAG AND GRAVEL, DRY			- AUGER REFUSAL @ TB2A - TRACE OIL SHEEN - RKO-TB2B-1 - AUGER REFUSAL @ TB2B
5							
10	S 3	170	40	DARK BROWN SLAG, TRACE SCALE, MOIST			- AUGER REFUSAL @ TB2C - WATER @ 9.0' - NO OIL SHEEN - RKO-TB2D-02
				↑ Total Depth of Boring 11.0'			
15							

NOTES:

This boring log reflects conditions encountered at test borings TB2A, TB2B, TB2C, and TB2D as a single Boring; TB-2

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: ARMO KC Works O.I. TANK		
BORING NUMBER: TB-3	COORDINATES:		DATE: 5/9/89
ELEVATION:	GWL: Depth	Date: Time	DATE STARTED: 5/2/89
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date: Time	DATE COMPLETED: 5/2/89
DRILLING METHODS: Hollow Stem Augers	PAGE		1 OF 1

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER FOOT	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	S 1	31	50	DENSE GRAY FILL; Limestone GRAVEL AND SLAG, TRY			PHC ODOR -RKO-TB3-1
S	S 2	13	75	STIFF DARK GRAY SILTY CLAY; DAMP TO WET, PLANT FRAGMENTS, some mottling associated with decaying plant matter	CL		PHC ODOR -RKO-TB3-2
	S 3	20	50				
10	S 4	12					
	S 5	7	100	MEDIUM STIFF CLAYEY SILT; TRACE TO SOME SAND, WET	ML		WATER @ 10.5 WITH PHC ODOR -RKO-TB3-3
15				Total Depth of Boring 15.0'			

NOTES:

WATER LEVEL MEASURED 3 DAYS AFTER DRILLING SHOWED NO FLOATING PRODUCT.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO #2 Works Oil Tank		
BORING NUMBER: TB-4	COORDINATES:		DATE: 5/12/89
ELEVATION:	GWL: Depth	Date: Time	DATE STARTED: 5/12/89
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date: Time	DATE COMPLETED: 5/12/89
DRILLING METHODS: Hollow Stem Auger	PAGE 1 OF 1		

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (Foot)	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5	S 1	90	45	VERY DENSE BLACK TAN <u>FILL</u> SLAG AND MILL SCALE, TRY TO TAMP			- RKO-TB4-01 - Auger Refusal
	S 2	28	60	(LOOSE) GREEN SAND <u>FILL</u> ; RESEMBLES <u>GLUINE</u>			
	S 3	96	30	VERY DENSE DARK GRAY <u>FILL</u> ; SLAG			
10				Bottom of Boring 7.5'			

NOTES:

Boring TB-4B encountered refusal @ 3'

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO. KC Works C-1 TANK		
BORING NUMBER: TB-5	COORDINATES:		DATE: 5/12/89
ELEVATION:	GWL: Depth	Date: Time	DATE STARTED 5/12/89
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date: Time	DATE COMPLETED 5/12/89
DRILLING METHODS: Hollow Stem Auger			PAGE 1 OF 1

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (Foot)	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5	S 1	4	50	LOOSE GRAY SILTY FINE SAND; SOME CLAY, PLANT FRAGMENTS DAMP	SM/ML		No PHC odor RKO-TBS-1 WATER @ 6.0' RKO-TBS-2
	S 2	4	50				
	S 3	2	6	SOFT GRAY CLAYEY SILT; TRACE TO SOME SAND, WET, PLANT FRAGMENTS	ML		
10	S 4	4	60	MEDIUM STIFF GRAY SILTY CLAY DAMP	CL		RKO-TBS-3
	S 5	4	100	SOFT GRAY SILT; WET SOFT MOTTLED GRAY SILTY CLAY; INTERBEDDED SOFT LIGHT GRAY SILTY SAND; LAMINATED, WET	ML CL/SM		
				Bottom of Boring @ 12.0'			

NOTES:

Water level rose to G. surface with very light oil sheen two days later.



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO RC Works Oil Tank		
BORING NUMBER: TB-6	COORDINATES:		DATE:
ELEVATION:	GWL: Depth	Date: Time	DATE STARTED
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date: Time	DATE COMPLETED
DRILLING METHODS: Continuous Split Spoon Sampling			PAGE 1 OF 1

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (ft)	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0	1	5		LOOSE BROWN SILTY FINE SAND; MOIST, PLANT FRAGMENTS	SM		FXO-TB6-1
1	2	5		SOFT LIGHT to MEDIUM GRAY(FINE) SANDY SILT; TRACE TO SOME CLAY, MOIST TO WET, PLANT FRAGMENTS WITH BLACK STAINS Resulting from Decay	ML		Water @ 5.0'
2	3	4	80				FXO-TB6-2
3	4	4	100				FXO-TB6-3
4	5		100				FXO-TB6-4
10				Bottom of Boring @ 10.0'			

NOTES:

NO EVIDENCE of DEC STAINS, STAINS OR odors during
drilling. Enclosed hole w/ continuous process.



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: <u>5711X</u>	PROJECT NAME: <u>REMOVAL OF OIL FROM</u>	
BORING NUMBER: <u>TB-7</u>	COORDINATES:	DATE: <u>5/16/89</u>
ELEVATION:	GWL: Depth <u>1.3</u> Date/Time <u>5/4/89</u>	DATE STARTED: <u>5/3/89</u>
ENGINEER/GEOLOGIST: <u>James J. ...</u>	Depth Date/Time	DATE COMPLETED: <u>5/5/89</u>
DRILLING METHODS: <u>Continuous Flight Auger</u>	PAGE	OF

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (ft)	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
		12	20	LOOSE GRAY FILL; STAG AND WOOD			
		?		LOOSE GRAY/BROWN SILTY FINE SAND; WET, BANDS OF SILT INCREASE WITH DEPTH.	SM/ ML		RKO-TB7-1 ← STRONG PHC ODOR
		4	80	SOFT GRAY/BROWN (FINE) SANDY SILT; TRACE TO SOME CLAY, WET, PLANT FRAGMENTS	ML		← WATER @ 3.0' ← NOTICEABLE PHC SHEEN RKO-TB7-2 ← LACK OF PHC ODOR BELOW 5.0'
		10	60	SOFT GRAY SILTY CLAY; DAMP	CL		
				LOOSE LIGHT GRAY SILTY FINE SAND; MOIST, LAMINATED.	SM/ ML		RKO-TB7-3
10				N. Bottom of Boring @ 3.0'			

NOTES:

Water level observed 5/4/89 showed some light oil
(residues observed) floating on w. level. Oil thickness
too thin to be measured.



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 8911 8	PROJECT NAME: ARMCO KC Works Oil Tank		
BORING NUMBER: TB-8	COORDINATES:		DATE: 5/18/89
ELEVATION:	GWL: Depth	Date: Time	DATE STARTED: 5/3/89
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date: Time	DATE COMPLETED: 5/3/89
DRILLING METHODS: Hollow Stem Auger			PAGE 1 OF 1

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER FOOT	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5	1	25	50	Loose to Dense BROWN Sand and slag FILL - OIL SATURATED FILL - FILL WET			RKO-TB8-1 Heavy Black Oil @ 3.9' RKO-TB8-2 STRONG PHC ODOR
	2	6	30				
	3	11	30				
	4	36	30				
10	5	7	100	SOFT TO MEDIUM DENSE DARK GRAY SANDY SILT ; TRACE CLAY, WET SOME PLANT FRAGMENTS	ML		RKO-TB8-3 RKO-TB8-4
	6	9	100				
				Bottom of Boring @ 12.0'			

NOTES:

Installed piezometer in boring to determine whether product was floating on aquifer. See Piezometer installation diagram for special construction.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO KC Works Oil Tank	
BORING NUMBER: TB-9	COORDINATES:	DATE: 5/18/89
ELEVATION:	GWL: Depth 0.08 Date/Time 5/4/89	DATE STARTED: 5/3/89
ENGINEER/GEOLOGIST: D. Crowley	Depth Date/Time	DATE COMPLETED: 5/3/89
DRILLING METHODS: Hollow Stem Augers	PAGE 1 OF 1	

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (Foot)	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5 10	S/1	20	40	Dense to Very Dense GRAY/TAN FILL; Gray silty clay wet/oil	ML/SM		← WATER/OIL
	S/2	39	30	- GRAY SILT AND GRAVEL - Rocky difficult to Auger			[RKO-TB9-1 ← APPARENT Bottom of OILY ZONE
	S/3	5	60	Medium stiff Dark Gray Mottled (Fine) sandy silt; wet, plant fragments, PHC ODOR			[RKO-TB9-2
	S/4	9	30				
	S/5	4		- Trace Gravel			[RKO-TB9-3
				← Bottom of Boring @ 12.0'			

NOTES:

Water level @ ground surface with floating oil too thin to measure.



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO KC Works O.I. Tank	
BORING NUMBER: TB 10	COORDINATES:	DATE: 5/18/89
ELEVATION:	GWL: Depth 1.0 Date: Time 5/4/89 0920	DATE STARTED: 5/4/89
ENGINEER/GEOLOGIST: D. Crowley	Depth Date: Time	DATE COMPLETED: 5/4/89
DRILLING METHODS: Hollow Stem Auger		PAGE 1 OF 1

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER FOOT	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	5/1	3	80	SOFT BROWN SILTY CLAY; TRACE SAND MOIST			
	5/2	3	80	SOFT GRAY-DARKGRAY (FINE) SANDY SILT; SOME CLAY, WET	ML/SH		WATER @ 2.0'- RKO-TB10-1 NO NOTICABLE PHC SHEEN OR ODOR -RKO-TB10-3
5	5/3	5		-SILT AND SAND INTERBEDDED -DARK GRAY TO BLACK AND ORGANIC RICH			RKO-TB10-3
	5/4	5		MEDIUM STIFF LIGHT GRAY SILT; SOME CLAY	ML		-RKO-TB10-4
10				Bottom of Hole @ 8.0'			

NOTES:

Water level @ 1.0' observed but no sheen or floating oil.



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 89118	PROJECT NAME: REMCO KCWaks Oil Tank		
BORING NUMBER: TB-11	COORDINATES:		DATE: 5/18/89
ELEVATION:	GWL: Depth	Date: Time	DATE STARTED: 5/4/89
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date: Time	DATE COMPLETED: 5/4/89
DRILLING METHODS: Hollow Stem Augers			PAGE 1 OF 1

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER FOOT	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
				VERY DENSE BROWN <u>FILL</u> ; DAMP SLAG AND SAND			No noticeable PHC odor
5.1		176					RK0-TB11-2 (TB11B) - AUGER REFUSAL @ TB11B RK0-TB11-1 (TB11A)
				Bottom of Boring @ 5.5'			AUGER REFUSAL @ TB11A

NOTES:

Boring log reflects conditions encountered @ Test Borings
TB 11A and TB 11B (located 8' apart) as a
single Boring TB-11.



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 8911 8	PROJECT NAME: ARMCO KC WORKS OIL TANK		
BORING NUMBER: TB-12	COORDINATES:		DATE: 5/18/89
ELEVATION:	GWL: Depth	Date: Time	DATE STARTED: 5/18/89
ENGINEER/GEOLOGIST: D. Crowley	Depth	Date: Time	DATE COMPLETED: 5/18/89
DRILLING METHODS: Hollow Stem Augers			PAGE 1 OF 1

DEPTH (Feet)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER FOOT	RECOVERY (%)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5				Very Dense, Gray Fill; Dry Slag -unable to split spoon.			- AUGER REFUSAL @ TB12B - AUGER REFUSAL @ TB12A
10				Bottom of Boring			RHO-TB12-1 (collected on Augers) AUGER REFUSAL @ TB-12C

NOTES:

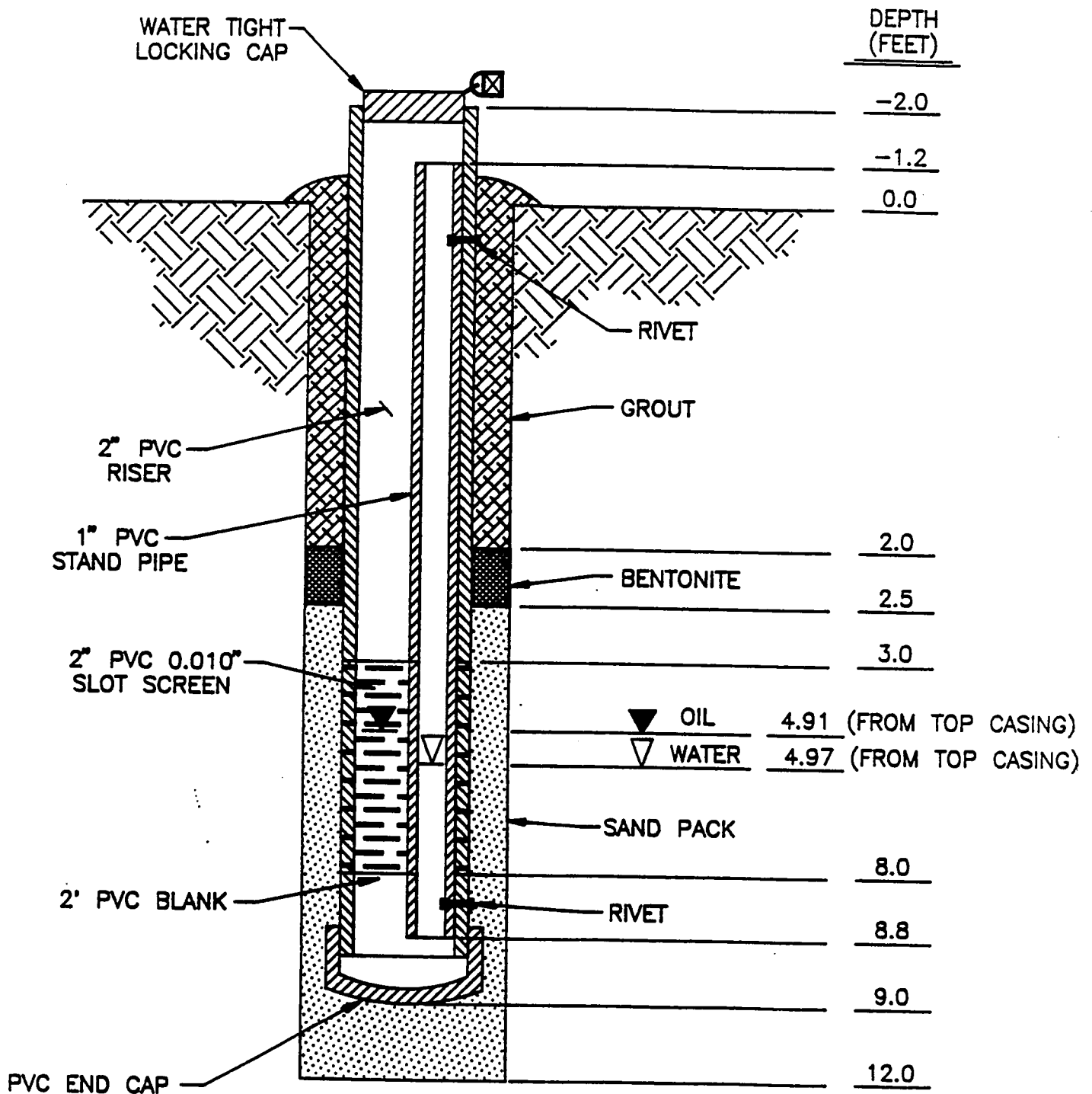
Boring Did not encounter water.

APPENDIX C
SPECIAL PIEZOMETER CONSTRUCTION DETAILS



PIEZOMETER
FOR
OIL THICKNESS
DETERMINATION

TEST BORING TB-8
PROJECT: 89118



NOTES:

1. BOTH OIL AND WATER LEVELS ARE MEASURED TO TOP OF OUTER 2" PVC RISER.
2. DO NOT SCALE THIS DRAWING.



REMCOR, Inc. • 701 Alpha Drive • P.O. Box 38310 • Pittsburgh, PA 15238-8310 • 412-963-1106

June 7, 1991

Project No. 89118.5

Mr. Charles J. Fillinger
Senior Mechanical Engineer
Armco - Midwestern Steel Division
7000 Roberts Avenue
Kansas City, MO 64125

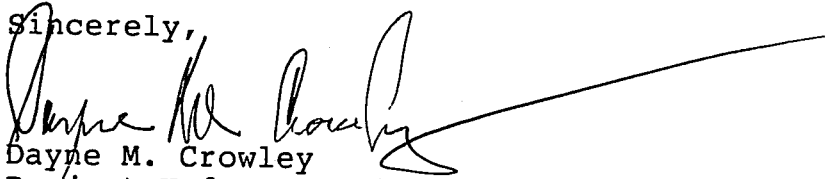
Transmittal
Boring Logs/Well Construction Diagrams
K.C. Southern Oil Tank Area

Dear Mr. Fillinger:

As per your recent request, Remcor, Inc. (Remcor) has provided the boring logs/well completion diagrams for the wells at the K.C. Southern Oil Tank Area. Attached to this letter please find copies of the logs for Wells RW-1, RW-2, and RW-3.

I trust that this submittal satisfies your requirements at this time. Remcor anticipates completion of a report for this project by June 28, 1991. If you have any questions or require additional information, please do not hesitate to contact me.

Sincerely,



Dayne M. Crowley
Project Hydrogeologist

DMC:jrf
Attachments



TEST BORING AND MONITORING
WELL CONSTRUCTION LOG

PAGE 1 OF 1

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO - Oil Tank		
BORING NUMBER: RW-1	COORDINATES:		DATE:
ELEVATION:	GWL: DEPTH	DATE/TIME	DATE STARTED: 12/11/89
GEOLOGIST/ENGINEER: Crowley	DEPTH	DATE/TIME	DATE COMPLETED:
DRILLING METHODS: Air Rotary 9 7/8" Bit			

DEPTH FEET	SAMPLE TYPE & NO.	BLOWS PER 6"	RECOVERY ()	DESCRIPTION	SOIL/ROCK TYPE	REMARKS	MONITORING WELL CONSTRUCTION
5				Slag / Bricks		Bentonite cement →	
				Fine Scale		6" DIA SCH 40 PVC RISER →	
				Slag	FI		
10				WET AT 10'		SAND PACK →	
						6" DIA PVC wire wrap 0.020 Slot Screen →	
15				Black Clayey silt	ML	6" DIA. PVC END PLUG →	
20				Bottom of Boring 18.0'			

BORING NO. RW-1



TEST BORING AND MONITORING
WELL CONSTRUCTION LOG

PROJECT NUMBER: 89118		PROJECT NAME: ARMCO Oil TANK	
BORING NUMBER: RW-2		COORDINATES:	
ELEVATION:		GWL: DEPTH	DATE/TIME
GEOLOGIST/ENGINEER:		DEPTH	DATE/TIME
DRILLING METHODS: Air Rotary 9 7/8" Bit			
PAGE		OF 1	
DATE: 12/14/89			
DATE STARTED: 12/14/89			
DATE COMPLETED:			

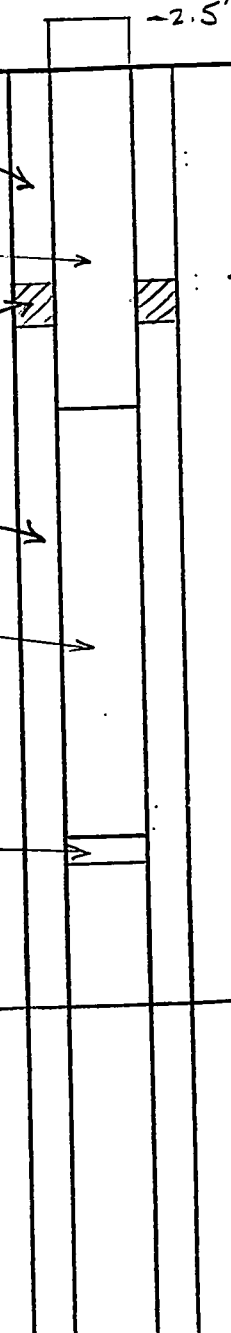
DEPTH FEET	SAMPLE TYPE & NO.	BLOWS PER 6"	RECOVERY ()	DESCRIPTION	SOIL/ROCK TYPE	REMARKS	MONITORING WELL CONSTRUCTION
5				Fill Material: Slag / Bricks	Fill	Bentonite Cement →	
10						4" DIA SCH 40 PVC RISER →	
						Bentonite Pellets →	
15						SAND PACK →	
				wet at 11'		4" DIA PVC 0.020" Mill SLOT SCREEN →	
20				Black Clayey silt.	ML	4" DIA PLUG →	
				Bottom of Boring @ 22'			



TEST BORING AND MONITORING
WELL CONSTRUCTION LOG

PAGE 1 OF 1

PROJECT NUMBER: 89118	PROJECT NAME: ARMCO - OIL TANK		
BORING NUMBER: RW-3	COORDINATES:		DATE:
ELEVATION:	GWL: DEPTH	DATE/TIME	DATE STARTED: 12/14/89
GEOLOGIST/ENGINEER: Crowley	DEPTH	DATE/TIME	DATE COMPLETED:
DRILLING METHODS: Air Rotary 9 7/8" Bit			

DEPTH FEET	SAMPLE TYPE & NO.	BLOWS PER 6"	RECOVERY ()	DESCRIPTION	SOIL/ROCK TYPE	REMARKS	MONITORING WELL CONSTRUCTION
5				Fill Material: Slag / Bricks	Fill	Bentonite Cement 4" DIA SCH 40 PVC RISER Bentonite Pellets	
10						SANDPACK	
15				WATER @ 14'		4" DIA PVC 0.020" Mill Slot Screen	
20				Black Silty Clay	ML	4" DIA PLUG	
				Bottom of Boring @ 22'			

BORING NO. RW-3